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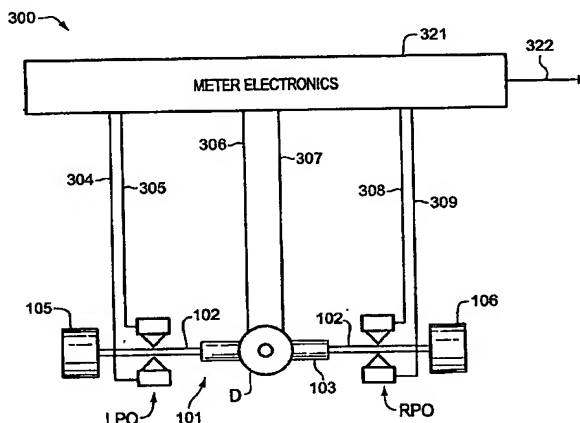
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[Continued on next page]

(54) Title: **LOW MASS CORIOLIS MASS FLOWMETER HAVING A LOW MASS DRIVE SYSTEM**



(57) Abstract: A Coriolis mass flowmeter (300) having a low mass drive system comprising a driver coil (D) for vibrating flow tube means (102). The Coriolis mass flowmeter does not use a magnet affixed to the flow tube means. Instead, the flow tube means is coated with or is integral to magnetic material (103) that responds to the magnetic fields generated by the driver coil to vibrate the flow tube means. The flow tube means may comprise one (102) or more (1402C1, 1402C2) flow tubes. The magnetic material may be ferrous material devoid of an internal magnetic field. Alternatively the magnetic material may be steel or stainless steel having internal magnetic fields.



SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

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B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 2 221 302 A (PA CONSULTING SERVICES) 31 January 1990 (1990-01-31) whole document figures 3D, 4D	1-3, 15, 16 4-14, 17-42
X	US 5 531 126 A (DRAHM WOLFGANG) 2 July 1996 (1996-07-02) column 5 -column 6; figure 3	1-3, 14
X	US 4 777 833 A (CARPENTER BRENT L) 18 October 1988 (1988-10-18) column 6; figure 2	1-3, 15, 16
X	US 4 949 583 A (LANG MICHAEL ET AL) 21 August 1990 (1990-08-21) column 6; figure 2	1, 14, 17
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Intermediate Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 069 075 A (HANSEN HENNING M ET AL) 3 December 1991 (1991-12-03) column 3 -column 6; figure 1 -----	1-42
A	US 6 164 140 A (KALINOSKI RICHARD W) 26 December 2000 (2000-12-26) column 5 -column 8; figures 5,11 -----	1-42

INTERNATIONAL SEARCH REPORT

Internat

pplication No

PCT/US 03/03335

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 2221302	A	31-01-1990	NONE		
US 5531126	A	02-07-1996	CN	1112373 A ,B	22-11-1995
			DE	59408354 D1	08-07-1999
			DK	660920 T3	13-12-1999
			WO	9503528 A1	02-02-1995
			EP	0660920 A1	05-07-1995
			ES	2133570 T3	16-09-1999
			JP	2558091 B2	27-11-1996
			JP	7507638 T	24-08-1995
US 4777833	A	18-10-1988	AU	603599 B2	22-11-1990
			AU	7759487 A	01-06-1988
			BR	8707870 A	31-10-1989
			DE	3782944 D1	14-01-1993
			DE	3782944 T2	17-06-1993
			EP	0332612 A1	20-09-1989
			JP	7104197 B	13-11-1995
			JP	2500537 T	22-02-1990
			WO	8803642 A1	19-05-1988
US 4949583	A	21-08-1990	DE	3739383 A1	01-06-1989
			DE	3808461 A1	28-09-1989
			DE	3877907 D1	11-03-1993
			EP	0316908 A2	24-05-1989
			JP	1259221 A	16-10-1989
			JP	1919470 C	07-04-1995
			JP	6046167 B	15-06-1994
US 5069075	A	03-12-1991	DE	3923409 A1	24-01-1991
			CA	2019439 A1	14-01-1991
			CH	680388 A5	14-08-1992
			DK	155990 A	15-01-1991
			GB	2234591 A ,B	06-02-1991
			JP	1960123 C	10-08-1995
			JP	3053131 A	07-03-1991
			JP	6092901 B	16-11-1994
			NL	9001505 A ,B,	01-02-1991
US 6164140	A	26-12-2000	EP	1147381 A1	24-10-2001
			WO	0022385 A1	20-04-2000